FAUNAL SURVEY OF NEW ENGLAND. IV. THE FROGS

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Distributions and habitats of 46 species of frogs, representing 13 genera within two families are documented in a faunal survey of the New England Region, northern New South Wales. Two species; *Litoria castanea* and *Litoria piperata* are endemic to the region. Twelve species are eurytropic, most frogs are from moist habitats which have distributions along the east coast and onto the Great Dividing Range, and these are restricted to the eastern New England region. Those frogs species known from the western arid plains are restricted to the western part of the New England region. □ *New England, frogs, fauna survey, distribution, habitat.*

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In 1966 the New England Faunal Survey was intiated. This faunal survey fulfils the following functions; (1) It catalogues the species of the area and provides clues for their identification, (2) presents information on local distribution, (3) allows faunal assessment of localities providing a data set from which baseline environmental management policies can be derived, and (4) highlights ecological similarities and differences between component species and generates hypotheses as to factors influencing the geographic distribution of species allowing temporal changes to be monitored and recorded.

Taxa covered by the survey have depended on the number and enthusiasm of students and satff of the University of New England and has reflected their interests towards particular taxonomic groups. Many groups have not received any attention due to a lack of appropriate specialists: particicpation of interested qualified persons is most welcome.

Three parts of the survey have been published. The first (Heatwole & Simpson, 1986) was a general account of the region's geography, drainage systems, topography, climate, vegetation, geology and soils, and was designed as a background for later papers dealing with specific taxa. The second part (Simpson & Stanisic, 1986) treated the snails and slugs of the region and the third (Ford & McFarland, 1991) dealt with birds.

The present paper provides a species list of the frogs, a distributional map for each species, and an interpretation of the biogeography of the region based on this taxon. It is expected that two further herpetofaunal papers will appear in the series, one on lizards, and one on snakes and freshwater tortoises.

METHODS

Methods related to this faunal survey have been described in previous papers of this series and are here briefly summarised. The initial data base comprised opportunistic collecting, road kills, a small previous collection in the Department of Zoology of the University of New England, specimens brought in by the public, and the collections of the Australian Museum, Sydney. Additional data were obtained from the collections of the Queensland Museum, Brisbane and the Museum of Victoria, Melbourne. Material used in this study spans a period from early 20th century to 1990. Specimens were catalogued and localities of their provenance plotted on gridded outline maps of the area. Such maps form the basis for Figs 6-46. Preserved specimens contributing to the initial data base are represented by solid symbols, those from other sources by open circles. When major distributional outlines had emerged, special collecting trips were made to specific areas to fill in gaps. There are many details yet remaining, and rare species may be treated inadequately. However, it was deemed that most patterns were sufficiently clear to warrant presention of the results.

Previous papers in this series have employed the Australian Biogeographical Integration Grid System (ABIGS) (Brooks, 1977) using squares

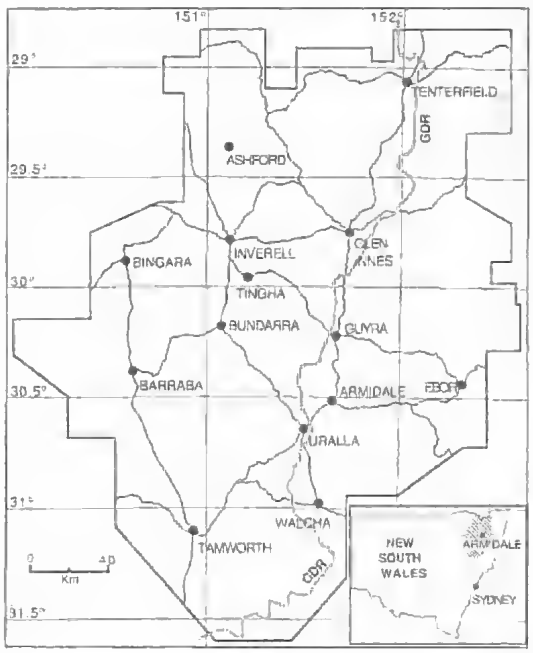

FIG. 1. Collecting grid and study area within New South Wales indicating main towns, connecting roads and the Great Dividing Range (GDR). Inset shows the location of the study area in New South Wales.

formed from 5' or 10' units of latitude and longitude, superimposed on a like-scale map of the region. The system recorded distribution as a set of grid localities. The present paper uses latitude and longitude to provide individual site records for each species. In both systems frog distributions are superimposed on a stylised outline of the 1968 New England Electorate, originally selected as a convenient unit for study (Fig. 1). Distributional maps presented here have been computer-generated using the Environmental Resources Mapping System (ERMS) devised by the National Parks and Wildlife Service of New South Wales, as were maps of elevation, rainfall and vegetation (Figs 3-5). The temperature map (Fig. 2) is from an 'Atlas of New England' (Lea et al., 1977). Distribution of each species was compared to these maps of environmental parameters.

The project was carried out under a succession of permits from the National Parks and Wildlife Service and approvals by the Animal Welfare Committee of the University of New England. Preserved specimens were donated to public Australian research museums, primarily the Australian Museum in Sydney.

ANNOTATED SPECIES LIST

In all, 46 species from 13 genera in two families are represented in the area. The family Myobatrachidae had 26 species in 11 genera and the family Hylidae had 20 species in 2 genera (2 in *Cyclorana* and 18 in *Litoria).*

The following list gives general information about each species, including its overall geographic range and its distribution in the New England area. Anecdotal habitat data arising from our collections and field notes are summarised. For further information, the reader can consult Barker & Grigg (1977), Cogger (1992), Tyler (1992) and the catalogue by Cogger *et al.* (1983). The latter provides an annotated bibliography that serves as a useful guide to the literature on each species. Some of the following information is taken from those sources.

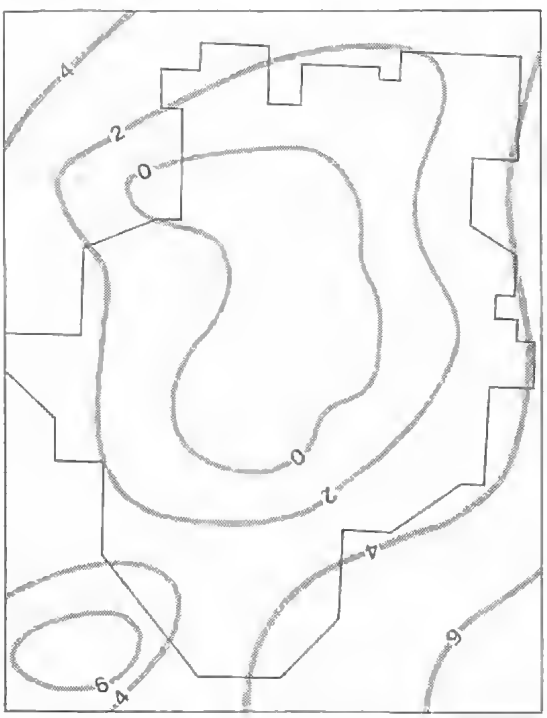

FIG. 2. Mean daily minimum isotherms (°C) across the New England region for July, superimposed on the study area. Modified from Lea et al. (1977).

FAMILY HYLIDAE

Superb Collared Frog *Cyclorunus brevipes* (Peters, 1871) (Fig. 6)

HABITAT: Grassy woodland; drier coastal areas and ranges.
RANGE: NE and E Australia only (Cogger, 1992).
NEW ENGLAND RANGE: There are three, possibly four, records of this species, all from the northern part of the study area. Two of these records AMR36867 and AMR37213 were registered in the Australian Museum as *C. cultripes*. The former has now been identified as *C. brevipes*, the latter cannot be located but since the locality of this specimen coincides with that of one of the specimens of *C. brevipes* there is little doubt that it, too, belongs to that species. Arranged along a line joining Yetman and Tenterfield these records represent an extension of previously known range for *C. brevipes*.

Water-holding Frog *Cyclorana platycephala* (Günther 1873) (Fig. 6)

HABITAT: The arid and semi-arid areas of the Australian interior.
RANGE: This species ranges in a broad band across arid Australia from the west coast of Western Australia through southern Northern Territory, northern South Australia to the western districts of Queensland and New South Wales.
NEW ENGLAND RANGE: The specimens recorded were taken near Gunnedah, outside the study area but which lies within the wider New England region defined by Lea et al. (1977). It is included here because the record may represent the eastern limit of its range.

Green and Gold Bell Frog *Litoria aurea* (Lesson, 1829) (Fig 7)

HABITAT: An aquatic species inhabiting reed beds in or edging natural or artificial permanent waters.
RANGE: Coastal, northern N.S.W. to southeastern Victoria. Extends west of the Great Dividing Range in southern N.S.W.
NEW ENGLAND RANGE: Two records near Armidale, one at Ebor.

Litoria barringtonensis (Copland, 1957) (Fig. 18.)

RANGE: Coastal ranges north of the Hunter River (M. Mahony, pers. comm.) to the Border Ranges.
NEW ENGLAND RANGE: All records are from or near the eastern boundary of the study area, in high, wet forest (elevation 400-1200m; rainfall 1100-1500mm) along the edge of the escarpment which represents the western limits of the species and of the coastal area.

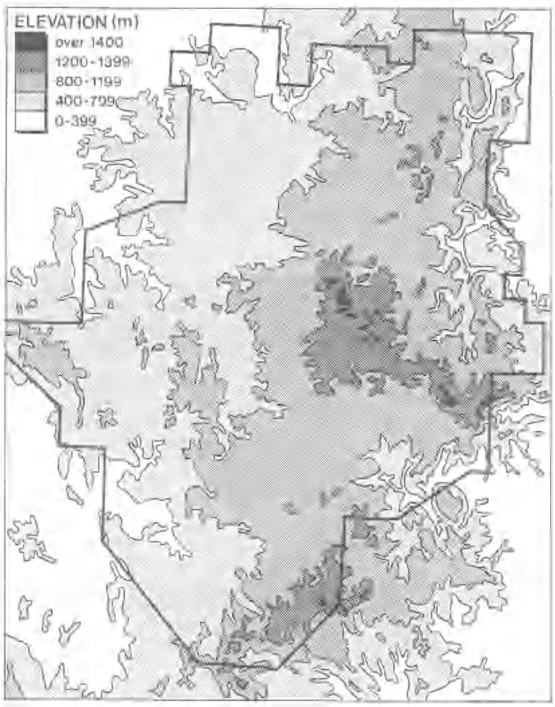

FIG. 3. Elevations of the study area. Adapted from a computer-generated map incorporating recent data provided by the Armidale branch of the National Parks and Wildlife Service of New South Wales.

COMMENT: These records were originally considered to represent *L. phyllochroa*. Currently there is uncertainty concerning the relationships of *L. phyllochroa*, *L. barringtonensis*, *L. pearsoniana* and *L. piperata*, all members of the *L. phyllochroa* complex. The identification adopted here was provided by M. Mahony, University of Newcastle, from adult specimens. However, it should be noted that the map records for this designation include tadpoles of a generally *L. phyllochroa* conformation and the possibility exists that they may represent *L. pearsoniana* or *L. barringtonensis*.

Booroolong Frog *Litoria booroolongensis* (Moore, 1961) (Fig. 8)

HABITAT: Nearly always associated with flowing water, typically the rocky, mountain streams of the Great Dividing Range.
RANGE: Mainly the ranges along the Great Dividing Range from Queensland to the Victorian -New South Wales border but extending westwards into lower rainfall areas.
NEW ENGLAND RANGE: Widespread in the study area, the most easterly records lying outside the study area, 22.5km northwest of Dundurrabin. The most

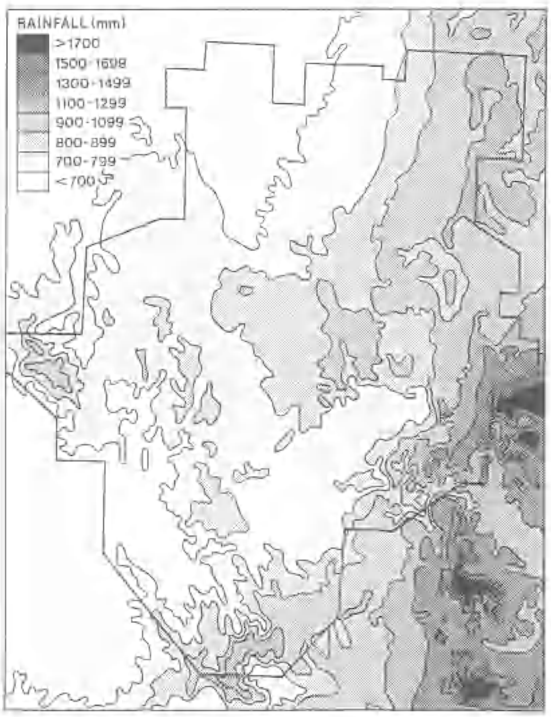

FIG. 4. Mean annual rainfall of the study area. Adapted from a computer-generated map incorporating recent study data by the Armidale branch of the National Parks and Wildlife Service of New South Wales.

northerly is a dubious record from Boonoo-Boonoo 22.5km north of Tenterfield, but otherwise from the Severn River, 11km southeast of Emmaville. The most southerly record is from 5km south west of Nundle. The absence of records from the northwestern and southwestern part of the study area is attributed to these being lower and drier areas.

Table 1 shows that distribution of *L. booroolongensis* coincides with a wide range of July minimum temperatures and with the drier end of the spectrum for rainfall and system of vegetation. There is a strong correlation with elevation both inside and outside of the study area, 65% of site records being above 800m. It is clear that distribution of this frog correlates with a particular habitat, itself dependent on relief.

Green Tree Frog *Litoria caerulea* (White, 1790) (Fig. 9)

RANGE: Widespread, coastal to dry interior; southeastern N.S.W., all of Queensland and the monsoonal parts of northern Australia.
NEW ENGLAND RANGE: A minor part of the total range. Occurs throughout the region but is much less common on the Tablelands than in the coastal areas. It seems likely that its New England distribution may owe much to human activity.

New England Swamp Frog *Litoria castanea* (Steindachner, 1867) (Fig. 7)

HABITAT: Associated with ponds, large permanent pools, small lakes and quiet streams all characterised by an abundant marginal growth of bullrushes and other vegetation. Found among reeds, in the water and under logs.
RANGE: This is an isolated population confined to the New England Tablelands, and known only from the central area of New England on either side of the Great Dividing Range, where it occupies mainly the headwaters of the westerly flowing Booroolong Creek and to a lesser extent those of the easterly flowing Anne and Sarah Rivers. Near Armidale, it has been recorded from Commissioners Waters, a tributary of the easterly flowing Gara River. No sightings in the wild have been reported since 1972 (Courtice & Grigg, 1975). Fears must be held for its survival. However, R. Hayworth of the University of New England Department of Geography and Planning reports collecting a specimen from dumped soil on a vacant lot actually within Armidale in 1991. Presumably it had been accidentally transported in the load of soil. Unfortunately, the identity of the specimen, which was released, cannot be confirmed.

Red-eyed Tree Frog *Litoria chloris* (Boulenger, 1893) (Fig. 10)

HABITAT: Coastal rainforest, wet scherophyll forests and grassy flood plains.
RANGE: Coast and adjacent eastern Australia from Gosford, N.S.W to central eastern Queensland (Cogger, 1992).
NEW ENGLAND RANGE: There are only two records, both from the eastern boundary of the study area, i.e., the western boundary of the coastal rain forest. The New England Tableland marks the western limits of this essentially coastal species.

Keferstein's Tree Frog, Bleating Tree Frog *Litoria dentata* (Keferstein, 1868) (Fig. 11)

HABITAT: Commonly associated with coastal lagoons and swamps, especially *Melaleuca* swamps behind coastal sandhills (Cogger, 1975).
RANGE: Comprises the coastal plain and adjacent mountains of eastern Australia from Jervis Bay north as far as the Maryborough district of Queensland. Moore (1961) recorded it from Palamallawa, between Warialda and Moree, as the only record west of the mountains. This record is further west than any from the present study.
NEW ENGLAND RANGE: Predominantly eastern. Of 11 records from the study area, three are west of Great Dividing Range. The Palamallawa record of

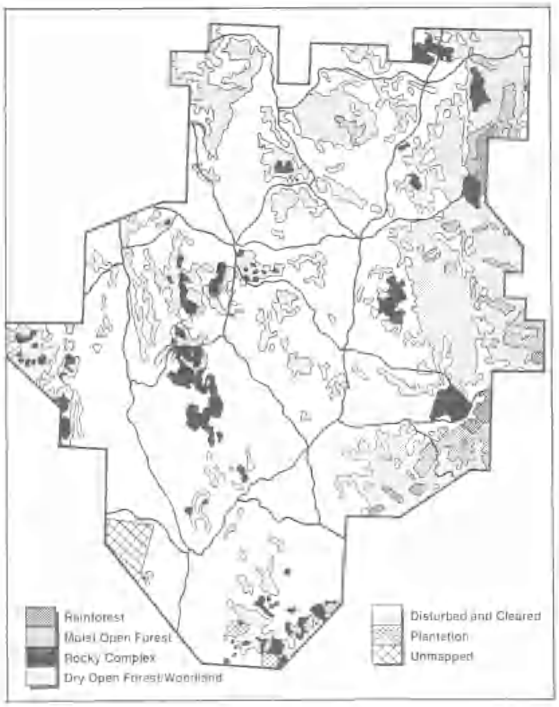

FIG. 5. Vegetational systems of the study area. Adapted from a computer-generated map incorporating recent data provided by the Armidale branch of the National Parks and Wildlife Service of New South Wales.

Moore suggests that more westerly records may yet be obtained from the New England area.

Eastern Dwarf Tree Frog *Litoria fallax* (Peters, 1880) (Fig. 12)

HABITAT: This species commonly lives among the floating and emergent vegetation at the margins of streams and large and small bodies of water. In coastal areas it is often found during the day sheltering in leaf-axils of pandanus, banana, pineapple plants, well away from water (Cogger, 1975).
RANGE: Coast, and adjacent mountains extending from southern Cape York Peninsula to southern N.S.W.
NEW ENGLAND RANGE: This frog is widely distributed across New England. The majority of records lie along the axis of the Great Dividing Range which suggests that elevation may be important in the distribution of this species. Noticeable hiatuses in distribution occur in the southwest and along the eastern escarpment. These are attributed to low collection effort in these areas. There is a surprising absence of records from the Walcha area which has been collected several times. The western boundary of the study area coincides with the western limit for the species.

Dainty or Slender Green Tree Frog *Litoria gracilenta* (Peters, 1869) (Fig. 13)

HABITAT: This frog occupies a variety of habitats, reeds and floating vegetation in streams and swamps (Moore, 1961; Cogger, 1992), on roads and low vegetation (Barker & Grigg, 1977).
RANGE: The known range is extensive, along the eastern coastal areas of Australia from the top of Cape York to a little north of Sydney. It is extralimital in southwestern Papua (Cogger, 1992).
NEW ENGLAND RANGE: There are two records (1956, 1958) for Armidale. No further records in 33 years have occurred for this species and its status as part of the New England herpetofauna must be regarded as dubious. The Armidale locality suggests accidental or intentional transportation from the coast, perhaps in fruit or vegetables. The 1958 record is from Commissioners Waters, 5km east of Armidale. This creek receives the effluent from the Armidale sewerage works. There has also been significant land degradation adjacent to the creek over this period of time. Alternatively, the Tablelands may be too cold for this coastal species. These factors might account for the disappearance of this species from this locality, even if it had been accidentally established.

Broad-palmed Frog, Gunther's Frog *Litoria latopalmata* Günther, 1867 (Fig. 14)

HABITAT: Damp habitats everywhere, natural or artificial, so that it is found in the semi-arid interior as well as in the wetter coastal areas.
RANGE: Coast, ranges and interior of eastern Australia, central New South Wales to central Queensland (Cogger, 1992).
NEW ENGLAND RANGE: Widely distributed in the New England region. Very noticeable, however, is its apparent absence from large areas in the central and eastern parts of the study area which correspond approximately with the areas of rugged relief. The New England distribution is merely a small part of the total distribution of this widely ranging species.

Lesueur's Frog *Litoria lesueuri* (Duméril & Bibron, 1841) (Fig. 15)

HABITAT: Frequently associated with rocky or sandy rivers, it occupies, however, a wide variety of habitats; wet grass, coastal heathlands, dry sclerophyll and subtropical rainforest (Cogger, 1975).
RANGE: Coastal ranges and slopes of eastern Australia from northern Queensland to Victoria (Cogger, 1992).
NEW ENGLAND RANGE: Fig. 15 shows a wide distribution similar to that of the closely related *L. latopalmata*, including the central hiatus which may be

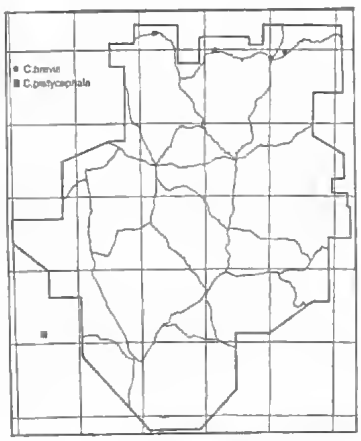

FIG. 6. *Cyclorana spp.*

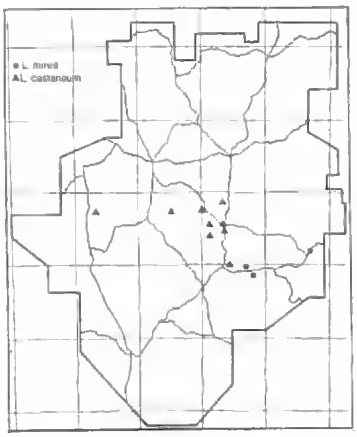

FIG. 7. *Litoria spp.*

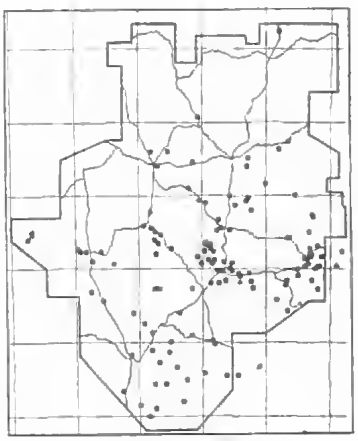

FIG. 8. *L. booroolongensis*

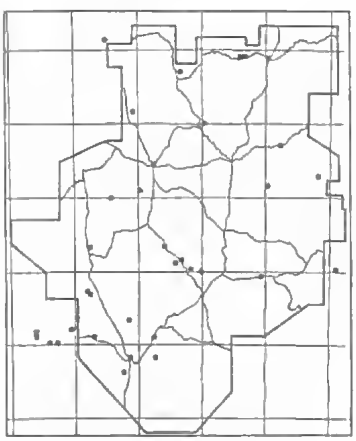

FIG. 9. *L. caerulea*

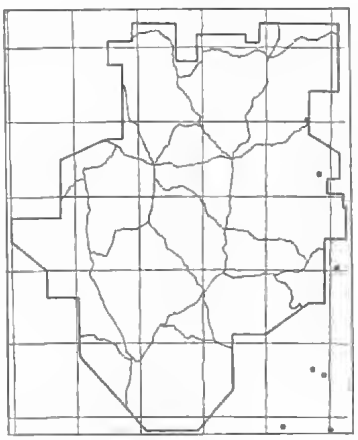

FIG. 10. *L. chloris*

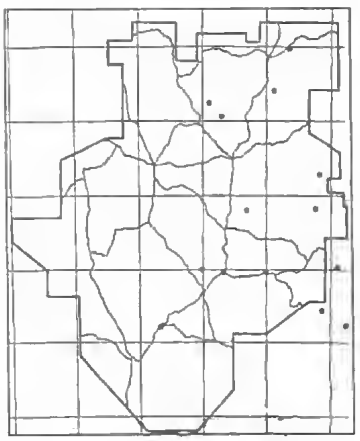

FIG. 11. *L. dentata*

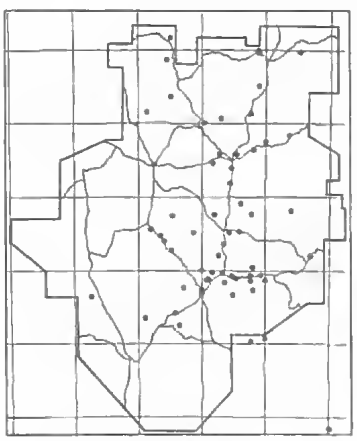

FIG. 12. *L. fallax*

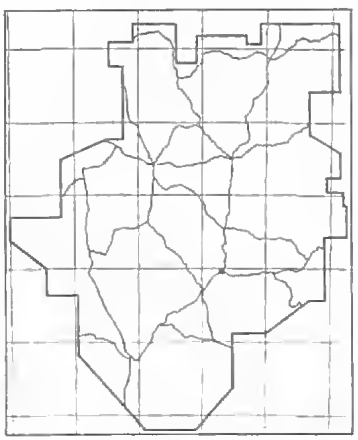

FIG. 13. *L. gracilenta*

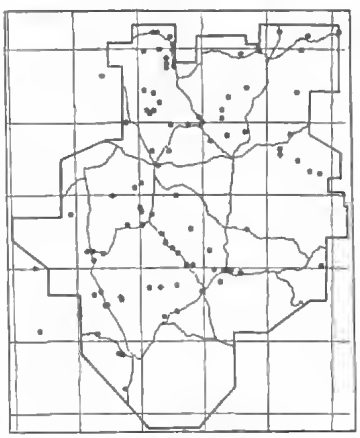

FIG. 14. *L. latopalmata*

due to collecting bias. Like that of *L. latopalmata*, the New England distribution is but a part of the wider distribution. It seems probable that the western boundary of New England marks the western limits of this species at these latitudes.

Rocket Frog *Litoria nasuta* (Gray, 1842) (Fig. 16)

HABITAT: Varied; swamps, coastal streams and lakes, tussock grassland, different kinds of shrubland, woodland and forest. Breeds in swamps.
RANGE: Coast and adjacent areas of northern and eastern Australia from the Kimberley region in northwest Australia to Cape York Peninsula thence to midcoast N.S.W. Also in New Guinea.
NEW ENGLAND RANGE: One record comprising two specimens from the Moonbi Ranges south of Bendemeer in the southern part of the study area.

Peron's Tree Frog *Litoria peronii* (Tschudi, 1838) (Fig. 17)

HABITAT: Includes a wide variety of habitats in coastal and semi-arid areas, especially trees, and shrubs near streams, lagoons, swamps and dams.
RANGE: In southeastern Australia this species occupies the area east of a line joining Rockhampton in Queensland with Adelaide in South Australia and including northern Victoria.
NEW ENGLAND RANGE: Fig. 17 shows a distribution throughout New England with a concentration of records, i.e., collecting effort, around Armidale. In view of its wide distribution, this species must be presumed present, even in localities lacking records. It is apparent that the New England distribution of this species is just one small mosaic in the total geographic range.

Peppered Frog *Litoria piperata* Tyler & Davies, 1985 (Fig. 19)

HABITAT: This species, discovered in 1973 and described in 1985, occupies open forest, wet sclerophyll forest and sub-tropical rainforest.
RANGE: Endemic to New England where it is 'confined to the highlands ... at altitudes above 1000m' (Tyler & Davies, 1985). All records are from the eastern part of New England and lie within the higher rainfall zone (800-1100mm). *L. piperata* appears to be closely related to *L. phyllochroa* (Tyler & Davies, 1985). Concern is felt for the survival of this species.

Desert Tree Frog, Red Tree Frog *Litoria rubella* (Gray, 1842) (Fig. 20)

HABITAT: Moist tropical to arid regions; trees, shrubs, ground, adjacent to temporary or permanent water.
RANGE: Widely distributed across more than half of Australia except the southeastern sector. Found also in southern New Guinea.
NEW ENGLAND RANGE: This species is recorded only from the northwestern and southwestern part of New England, apparently the eastern limits for the species at this latitude. Table 1 shows that the majority (87%) of records occur below the 800mm isohyet. Most records occur in areas of low relief, with mid winter minimal temperatures ranging from <0°-4°C.

GlandularFrog *Litoria subglandulosa* Tyler & Anstis, 1983 (Fig. 21)

HABITAT: Found in vegetation adjacent to rivers and creeks in cool, montane forest; also under bark on trees, among rocks and reeds, and beneath rotten logs, under stones, in sphagnum moss, and on roads at night. Elevation 1350-1450m (Tyler & Anstis, 1975).
RANGE: Records are from the New England tablelands and probably from near Girraween National Park, south of Stanthorpe (G. Ingram pers. comm., cited Tyler & Anstis, 1975). This species is also recorded south of the New England area from the Mt. Boss State Forest and from several sites in and around the Bulga State Forest in the Manning and Hastings Rivers district.
NEW ENGLAND RANGE: This species is distributed along the eastern edge of New England in areas of high elevation (800-1400m) and rainfall (1100-1499mm). Concentration of records in the Ebor-Pt. Lookout region reflects collecting bias. The New England distribution along the eastern boundary of the study area coincides with the edge of the escarpment. This species is closely related to the largely coastal *L. citropa* which extends from northeastern New South Wales to southeastern Victoria. The distribution of *L. subglandulosa* supports the opinion of Tyler & Anstis (1975) that this species probably replaces *L. citropa* on the Great Dividing Range of northern New South Wales.

Laughing Tree Frog (Ingram et al., 1993) *Litoria tyleri* Martin, Watson, Gartside, Littlejohn & Loftus-Hills, 1979 (Fig. 22)

HABITAT: The New England specimen was calling from reeds in a small dam.
RANGE: Northeastern and southeastern coasts of Australia from southern Queensland to Jervis Bay, N.S.W.
NEW ENGLAND RANGE: The single record from the Barney Fire Trail in the Dalmorton State Forest lies within the coastal distribution of the total range for this species.

Verreaux's Tree Frog *Litoria verreauxii* (Duméril, 1853) (Fig. 23)

HABITAT: Associated with permanent water in a wide variety of habitats from coastal savannahs ascending through forest of different kinds to alpine grasslands.

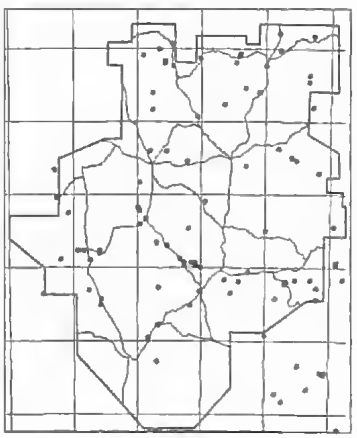

FIG. 15. *L. lesueuri*

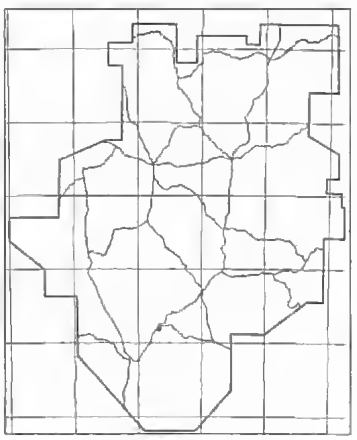

FIG. 16. *L. nasuta*

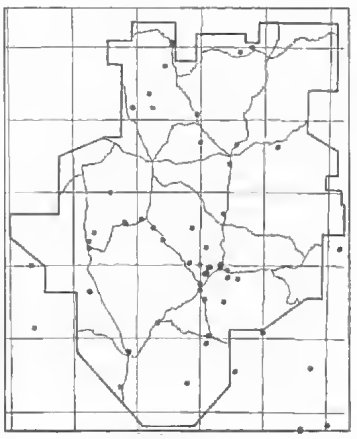

FIG. 17. *L. peronii*

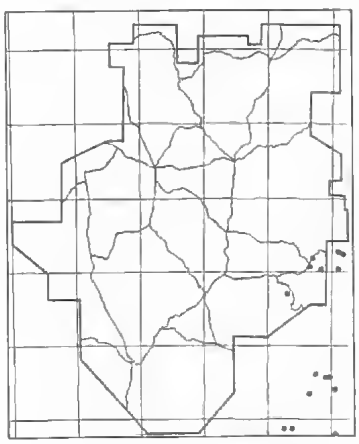

FIG. 18. *L. barringtonensis*

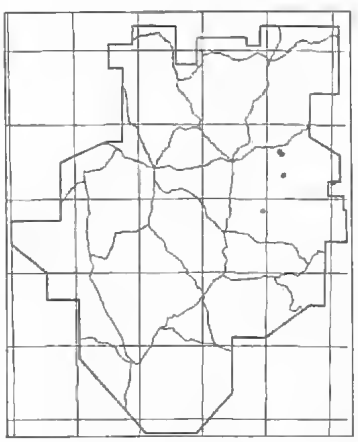

FIG. 19. *L. piperata*

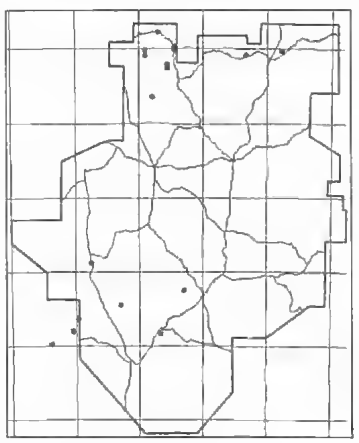

FIG. 20. *L. ruhella*

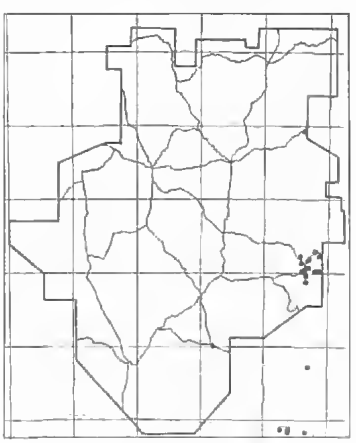

FIG. 21. *L. subglandulosa*

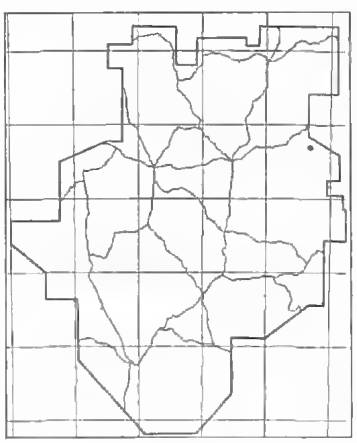

FIG. 22. *L. tyleri*

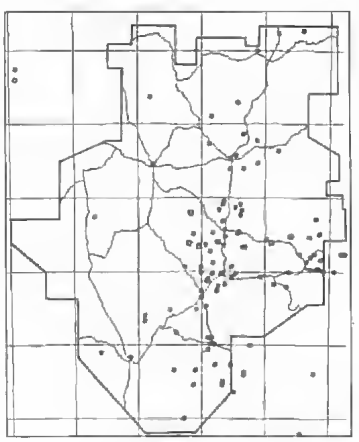

FIG. 23. *L. verreauxii*

RANGE: Coast and ranges from central Victoria to central Queensland and the northern tablelands of New South Wales.
NEW ENGLAND RANGE: Fig. 23 shows the distribution to be almost ubiquitous east of about longitude 151°18' so that this species is barely represented in the western half of New England. Table 1 shows the distribution corresponds to elevations above 800m, (92%) and to rainfall above 700mm (97%) and with lower winter minimum temperatures.

FAMILY MYOBATRACHIDAE

Tusked Frog *Adelotus brevis* (Gunther, 1863) (Fig. 24)

HABITAT: Varied, generally riparian in wet forests or cleared country.
RANGE: Generally stated to be eastern Great Dividing Range and northern tablelands of New South Wales, and southern Queensland; Springwood west of Sydney (Moore, 1961).
NEW ENGLAND RANGE: The distribution west of the Great Dividing Range is greater than previously suspected, the species being well represented in all parts of the study area except the central and southwestern sectors, but even in this sector it has been recorded west of Tamworth. This species has wide ecological amplitude, occupying all minimum temperature zones below 4°C, all rainfall zones below 1500mm and all elevations below 1400m.

Pouched Frog, Hip-pocket Frog, Marsupial Frog *Assa darlingtoni* (Loveridge, 1933) (Fig. 25)

HABITAT: Thick leaf litter, under rocks and rotting logs in rainforest.
RANGE: MacPherson Ranges and adjacent mountains across the Queensland-New South Wales border.
NEW ENGLAND RANGE: Records are only from the Gibraltar Range National Park and the adjoining Washpool State Forest. The call also has been recorded from the Dorrigo National Park where this frog appears to be plentiful (J. Courtney, pers. comm.). These records probably represent the southern limit of this species and indicate a narrow adaptation to high rainforest along the edge of the escarpment.

Loveridge's Frog *Kyarranus loveridgei* (Parker, 1940) (Fig. 26)

HABITAT: Rain, Antarctic beech and cool temperate rainforest above 750m (Cogger, 1992). Lives 10-15cm below ground in soft, moist soil or mossy cavities beside streams (Moore, 1961; Cogger, 1992).
RANGE: Known only from the MacPherson Ranges on the Queensland/New South Wales border and from the Gibraltar Range National Park and Washpool State Forest of New South Wales.
NEW ENGLAND RANGE: The Gibraltar Range National Park and Washpool State Forest, which are on the eastern boundary of the study area. The ranges of *K. sphagnicolus* and *K. loveridgei* overlap in the Gilbraltar Range National Park.

Sphagnum Frog *Kyarranus sphagnicolus* (Moore, 1958) (Fig. 27)

HABITAT: This frog was named from its discovery in 1951, deep inside a water-saturated clump of sphagnum moss in *Nothofagus* rainforest. However, at Pt. Lookout, the type locality, its habitat is not confined to sphagnum moss. It has been collected from water-filled burrows beneath rocks and logs. It also occupies crevices on wet cliffs and the water-permeated interstices of consolidated rock scree. Breeding burrows are associated with draining water, e.g., road gutters or scarcely perceptible seepages marking the head waters of gullies.
RANGE: There is a general north-south distribution along the Great Dividing Range in New South Wales from the Gibraltar Range National Park in the north to Elands in the south. The impression is of a number of separate populations strung along the high, wet points of the Great Dividing Range. To date there appear to be no records of this species from the Barrington Tops.
NEW ENGLAND RANGE: All records from this region are from the Gibraltar Range National Park, the Dorrigo National Park, New England National Park and the adjacent New England plateau. The altitudinal range extends lower than formerly thought; *K. sphagnicolus* occurs at Brinerville in the Bellingen Valley (H. Cogger, pers. comm.) at 106m, the site being cool and relatively sunless. (also see Discussion)

Fletcher's Frog *Lechriodus fletcheri* (Boulenger, 1890) (Fig. 28)

HABITAT: Rainforest and wet sclerophyll forest.
RANGE: Coastal and adjacent ranges from southeastern Queensland continuously to central New South Wales.
NEW ENGLAND RANGE: The eastern edge of the New England region represents the western extent of its habitat.

Eastern Banjo Frog, Pobblebonk, Four bob Frog *Limnodynastes dumerilii* Peters, 1863 (Fig. 29)

HABITAT: Permanent waters, natural and artificial over a wide range of vegetational and climatic types. A burrowing species frequently dug from urban gardens.
RANGE: Widely distributed from southeastern South Australia, throughout Victoria, Tasmania and along the tablelands and coastal ranges into southeastern Queensland.

NEW ENGLAND RANGE: Broadly distributed throughout the study area. In New England its distribution overlaps that of *L. terraereginae.*

Long-thumbed Frog, Barking Frog, Marsh Frog *Limnodynastes fletcheri* Boulenger, 1988 (Fig. 30)

HABITAT: As for L. *tasmaniensis.* Typical localities are the edges of creeks and open water.
RANGE: Entirely west of the Great Dividing Range in southern Queensland and in the Murray Darling Basin of New South Wales, Victoria and South Australia.
NEW ENGLAND RANGE: Widespread on the New England tablelands and western slopes, but three records occur east of the Great Dividing Range.

Ornate Burrowing Frog *Limnodynastes ornatus* (Gray, 1842) (Fig. 31)

HABITAT: Wet coastal forests to arid inland.
RANGE: A broad sweep embracing the coastal and arid parts of southeastern New South Wales, Queensland, Northern Territory and northwestern Australia.
NEW ENGLAND RANGE: Widely dispersed through a range of habitats from rainforest to dry sclerophyll woodland. New England is a small part of the total range of this species.

Brown-striped Frog, Brown Frog, Striped Marsh Frog *Limnodynastes peronii* Duméril & Bibron, 1841 (Fig. 32)

HABITAT: Associated with slowly moving or static, permanent water, natural or artificial, in various vegetational types.
RANGE: Tasmania; coast and ranges of eastern Australia from Queensland to Victoria.
NEW ENGLAND RANGE: Predominantly the eastern side of the Great Dividing Range but extending to the western slopes of the tableland.

Salmon-striped Frog, Steindachner's Frog *Limnodynastes salmini* Steindachner, 1867 (Fig. 33)

HABITAT: Various types of woodlands. Swamps.
RANGE: Unusual, comprising coastal and adjacent areas of southern Queensland and northern New South Wales as well as central inland New South Wales.
NEW ENGLAND RANGE: Predominantly the southwestern sector with some possibly anomalous records near Armidale. The New England records must represent the easternmost limits of this species in the area.

Spotted Grass Frog *Limnodynastes tasmaniensis* Günther, 1858 (Fig. 34)

HABITAT: Near permanent waters, swamps, creeks and dams in a variety of habitats from semi-arid to moist coastal with a corresponding variety of vegetational types.
RANGE: Tasmania, eastern South Australia, all of Victoria and New South Wales, southern and eastern Queensland as far north as Cooktown.
NEW ENGLAND RANGE: Ubiquitous, yet representing only a minute part of the total range of this widely distributed species

Northern Banjo Frog, Northern Bull Frog *Limnodynastes terraereginae* Fry, 1915 (Fig. 35)

HABITAT: Similar to that of *L. dumerilii.*
RANGE: Occurs coastally from Cape York, Queensland to northern New South Wales, thence along the western slopes of the Great Dividing Range, extending to eastern central New South Wales. Westward extent unknown.
NEW ENGLAND RANGE: The few records of this species for the study area are widely spaced and obviously part of the southern distribution of this species which extends to Tomingley in New South Wales (Martin, 1972).

Stuttering Frog *Mixophyes balbus* Straughan, 1968 (Fig. 36)

HABITAT: Wet sclerophyll and subtropical rainforest.
RANGE: Eastern side of the Great Dividing Range in southern Queensland, N.S.W. and Victoria.
NEW ENGLAND RANGE: A part of the wider distribution extending north to south along the eastern side of the Great Dividing Range.

Great Barred Frog *Mixophyes fasciolatus* Günther, 1864 (Fig. 37)

HABITAT: Coastal and adjacent ranges.
RANGE: Southeastern Queensland to southern N.S.W.
NEW ENGLAND RANGE: Like *M. balbus,* it has been found only along the eastern edge of the northern tablelands.

Great Barred Frog, Southern Barred Frog, Giant Barred Frog *Mixophyes iteratus* Straughan, 1968 (Fig. 37)

HABITAT: Wet sclerophyll forests and riverine rainforests of coastal eastern Australia.
RANGE: Exclusively coastal from Bunya Bunya mountains in southeastern Queensland almost to the New South Wales-Victorian border.

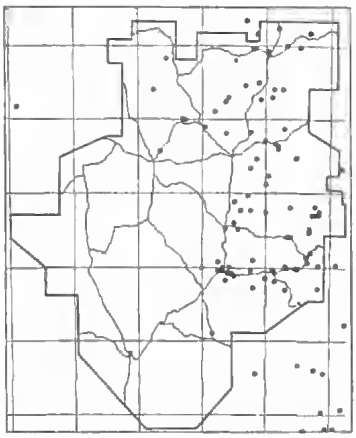

FIG. 24. *Adelotus brevis*

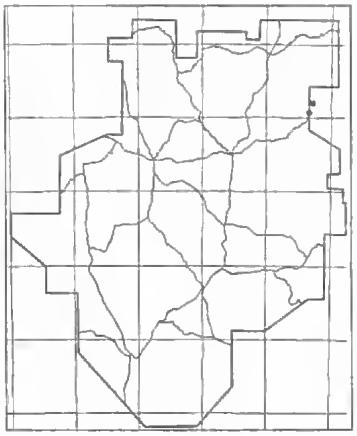

FIG. 25. *Assa darlingtoni*

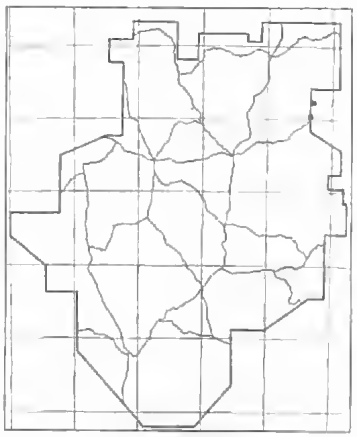

FIG. 26. *Kyrranus loveridgei*

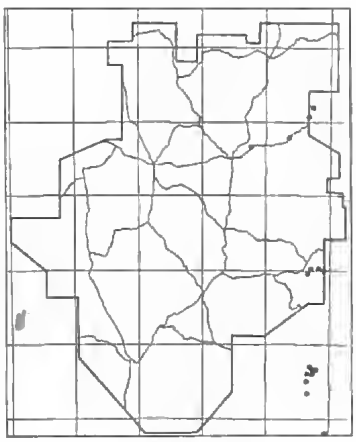

FIG. 27. *K. sphagnicolus*

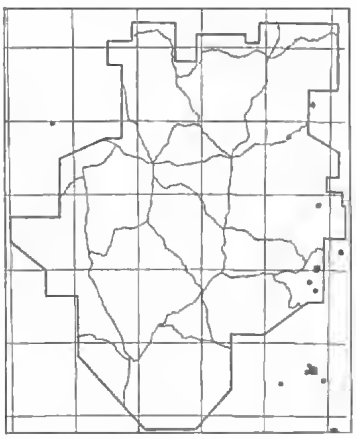

FIG. 28. *Limnodynastes fletcheri*

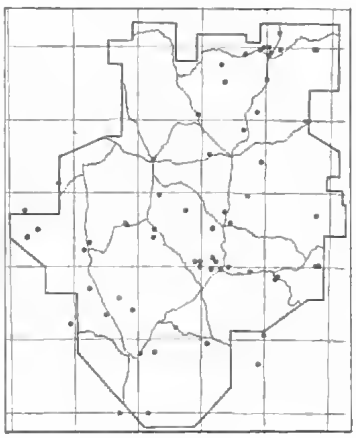

FIG. 29. *Lim. dumerilii*

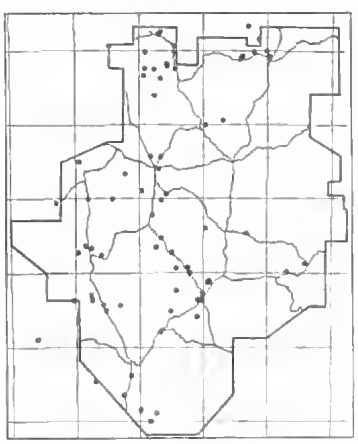

FIG. 30. *Lim. fletcheri*

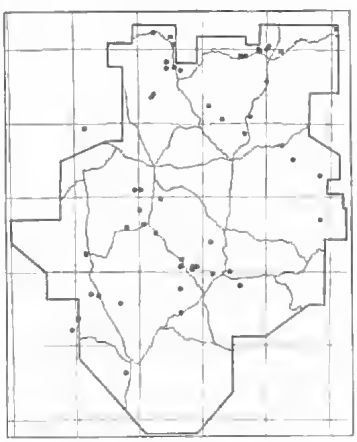

FIG. 31. *Lim. ornatus*

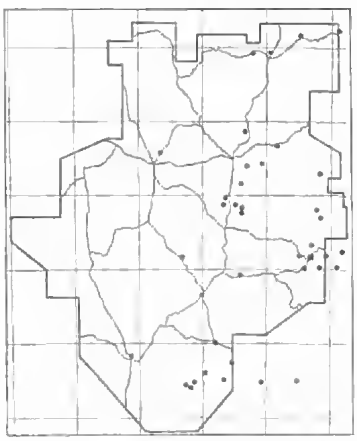

FIG. 32. *Lim. peronii*

NEW ENGLAND RANGE: The few records are from the eastern boundary of the study area, from the Gibraltar Range in the north and from the coastal forests east of Pt. Lookout.

Spotted Burrowing Frog, Painted Frog, Spadefoot Toad *Neobatrachus sudelli* (Lamb, 1911) (Fig. 38)

HABITAT: A burrowing species in habitats ranging from inland deserts to the forests of the western slopes of the Great Dividing Range.
RANGE: Southeastern South Australia, northern Victoria, inland to the Great Dividing Range in New South Wales and southern Queensland.
NEW ENGLAND RANGE: The few records span the New England region and unexpectedly includes one from Pt. Lookout east of the Great Dividing Range.

Holy Cross Toad, Crucifix Toad *Notaden bennettii* Günther, 1873(Fig. 39)

HABITAT: The dry areas of inland New South Wales and southern Queensland, especially the black-soil flood plains of the larger rivers. Found in a variety of vegetational types.
RANGE: The plains of New South Wales and southern Queensland west of the Great Dividing Range.
NEW ENGLAND RANGE: There are only three records for the New England region. That from Armidale on the tablelands is unexpected and may represent a transported individual.

Red-Crowned Toadlet *Pseudophryne australis* (Gray, 1835) (Fig. 42)

RANGE: Long believed to be restricted to the Hawkesbury Sandstone about Sydney.
NEW ENGLAND RANGE: The three positively indentified, widely separated records from New England appear anomalous in relation to the well known association of this species with the Hawkesbury Sandstone. The identity of the specimens is confirmed (K. Thumm, pers. comm.) but there is some question as to their provenance. The problem is to be discussed in a forthcoming work by Karen Thumm of the University of Newcastle.

Brown Toadlet , Bibron's Toadlet *Pseudophryne bibronii* Günther, 1858 (Fig. 40)

HABITAT: Virtually every habitat within its range. Wetter coastal areas to drier inland habitats, lowlands to mountains; shelters under logs, rocks, surface debris; associated with temporary or static permanent waters, puddles and ponds.
RANGE: Distributed widely from southeastern South Australia through Victoria, Tasmania, coastal and inland New South Wales and southeastern Queensland.
NEW ENGLAND RANGE: Virtually ubiquitous in the New England region which is a small part of the total range. The westernmost records may represent the western limits for the species in this region

Keferstein's Toadlet, Red-backed Toadlet *Pseudophryne coriacea* Keferstein 1858 (Fig. 41)

HABITAT: Generally in forest litter, under stones, in grass near streams and marshy areas. In the New England region it is associated with wet sclerophyll forest, and temperate rainforest,where it occurs under logs, rocks and in dense, moist vegetation and leaf litter.
RANGE: Coastal and adjacent ranges from southeastern Queensland to northern New South Wales.
NEW ENGLAND RANGE: A conspicuously eastern distribution coinciding closely with the Great Dividing Range, which marks the western limit of this species.

Large Toadlet *Pseudophryne major* Parker, 1940 (Fig. 42)

HABITAT: Except that it is found in situations similar to those of *P. bibroni* in other parts of Australia, little is known concerning this species.
RANGE: There is some difference of opinion as to its range. Cogger (1992) records its distribution as from Cape York to southeastern Queensland. Barker & Grigg (1977) restrict this species to the Burnett River valley in southeastern Queensland. Ingram & Corben (1994) remarked that occurences of *P. major* in southern and central Queensland were valid, and reported several isolated populations in far north Queensland.
NEW ENGLAND RANGE: Records for this species in the New England region are three specimens QMJ534231-3 from the Queensland Museum, collected at Mt Kaputar near the central western boundary of the study area. Identification has been confirmed and the presence of this species in such a westerly part of New England represents a remarkable extension of range.

Eastern Sign-bearing Froglet *Ranidella parinsignifera* Main, 1957 (Fig. 43)

HABITAT: '*R. parinsignifera* occupies the drier areas inland to the west of the Great Dividing Range and generally inhabits the summer-dry ponds of the region.' (Littlejohn, 1958).
RANGE: Murray River Valley in South Australia and Victoria, through central-western New South Wales and southern Queensland where it reaches the coast.
NEW ENGLAND RANGE: Within the region a wide distribution west of the Great Dividing Range, with a number of records occurring east of the Range and even of the study area. The range overlaps that of *R. signifera q.v.* and is contained comfortably within the total range.

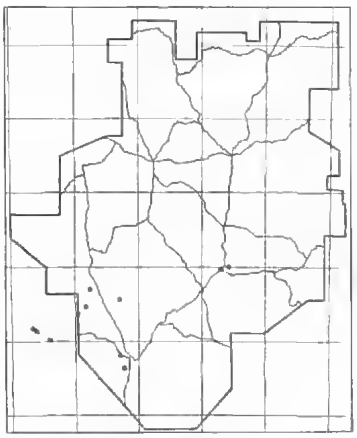

FIG. 33. *Lim. salmini*

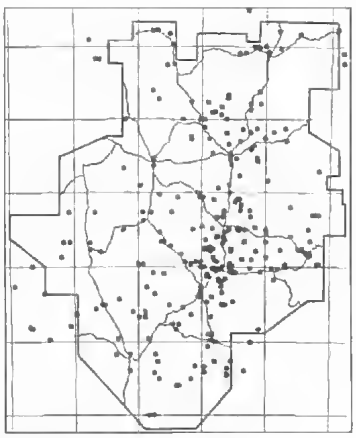

FIG. 34. *Lim. tasmaniensis*

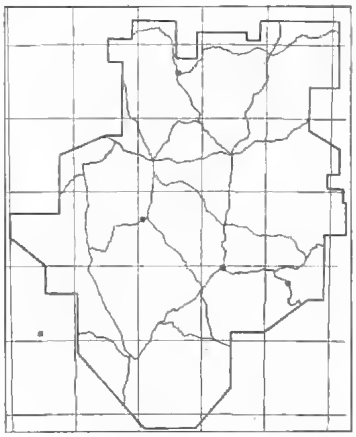

FIG. 35. *Lim. terraereginae*

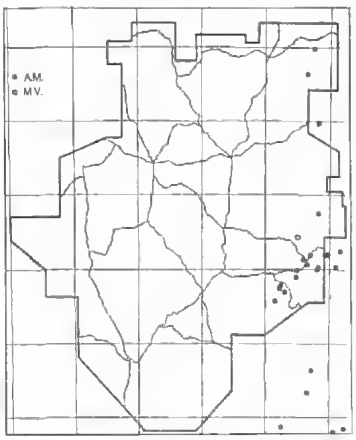

FIG. 36. *Mixophyes balbus*

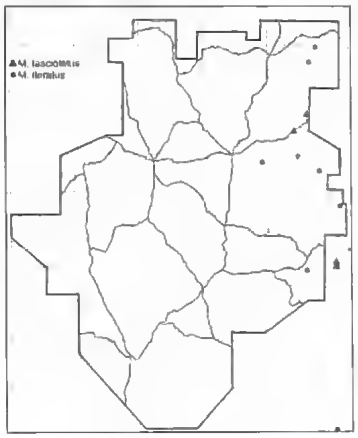

FIG. 37. *Myxophyes sp.*

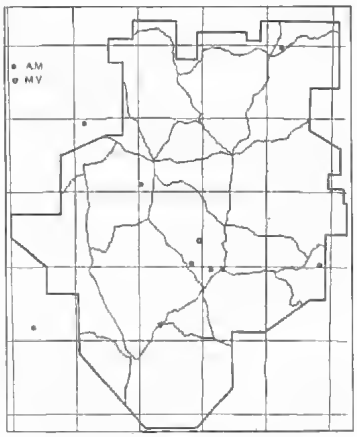

FIG. 38. *Neobatrachus sudelli*

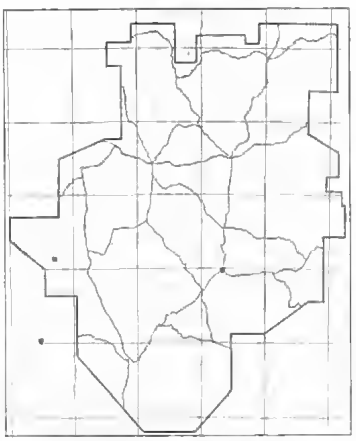

FIG. 39. *Notaden bennettii*

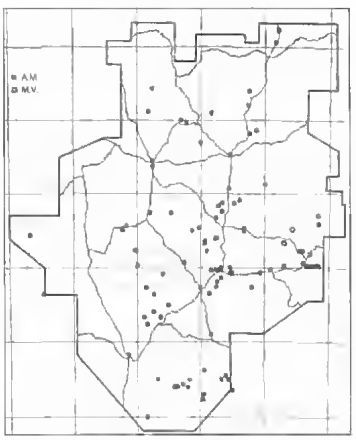

FIG. 40. *Pseudophryne bibronii*

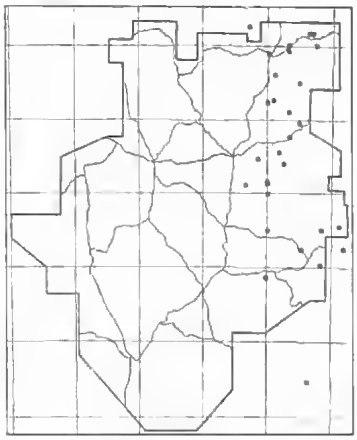

FIG. 41. *P. coriacea*

Common Eastern Froglet *Ranidella signifera* Girard, 1853 (Fig. 44)

HABITAT: Moist or wet situations in any part of its range.
RANGE: Widely distributed along the coastal and western sides of the Great Dividing Range from southeastern Queensland to South Australia. Also in Tasmania.
NEW ENGLAND RANGE: Almost ubiquitous.

Yellow-spotted Toadlet, Smooth Toadlet *Uperoleia laevigata* Keferstein, 1867 (Fig. 45)

HABITAT: Moist situations in a variety of habitats, e.g. under logs, stones and edges of lagoons.
RANGE: Central and southeastern coastal regions of southeastern Australia. Also on the Great Dividing Range as far north as Blackdown Tableland, Queensland (Davies & Littlejohn, 1986).
NEW ENGLAND RANGE: Almost ubiquitous, unrecorded only from the extreme western and southern parts of the study area.

Andersson's Toadlet, Wrinkled Toadlet *Uperoleia rugosa* (Andersson, 1916) (Fig. 46)

HABITAT: As for *U. laevigata.*
RANGE: South-central Queensland and New South Wales to the Victorian border, extending to the coast in Queensland and northern New South Wales.
NEW ENGLAND RANGE: All records derive from the northwestern quadrant.

Tyler's Toadlet *Uperoleia tyleri* Davies & Littlejohn, 1986 (Fig. 46)

HABITAT: Presumably similar to that of *U. laevigata.*
RANGE: Coastal southeastern Australia, Victoria and New South Wales. Also Tamworth, New South Wales.
NEW ENGLAND RANGE: Known only from one old (4.iv. 1910) record from Tamworth, New South Wales which is unusual in being widely separated from the nearest coastal records.

RESULTS AND DISCUSSION

There are about 195 native species of frogs in 27 genera and 4 families reported so far from Australia (Cogger, 1992). Thus, the New England frog fauna (46 species) constitutes 24% of the known Australian species, and the area has 48% of the Australian genera and 50% of the Australian families represented. The area of New England is 0.49% of the total area of Australia and therefore it is well endowed with frog species compared with the country as a whole. This probably can be attributed to the moderately abundant rainfall of the region, in a generally dry continent, an important consideration for such a generally moisture-sensitive group as amphibians. Lower temperatures on the tablelands than in much of Australia may bar some species from the area. The main reason, however, is that the New England region has a wide range of elevation and rainfall and that it overlaps three regions of the Koscisuskan zoogeographic region. (Ford & Macfarland, 1991). Thus, it forms an interchange zone between northern and southern and between eastern and western species. Compilation of data from Cogger (1992) shows that adjoining coastal areas of the same latitudinal span but with milder temperatures because of lower elevation have about 35 species, and northern tropical and subtropical areas have a still richer frog fauna, (approximately 119 species). Thus, New England is low in species richness compared to tropical Australia, slightly richer than adjoining temperate, but milder, moister coastal areas, and far richer than arid central Australia (25 species). Arid areas of an equivalent size to New England would have even fewer species.

The native Australian families not present in the New England region are the Microhylidae and the Ranidae. The former is a family represented in Australia by 17 species in two genera (*Cophixalus* and *Sphenophryne),* all are restricted to the tropical north. The Ranidae are represented in Australia by only one species, *Rana daemelii,* found only on Cape York Peninsula and Western Arnhem Land.

The introduced cane toad, *Bufo marinus,* the sole species of the family Bufonidae in Australia, has not spread to the New England region despite having reached northeastern New South Wales. It is unlikely to become established in New England because it probably could not survive the low winter temperatures there (van Beurden 1981).

The distribution of each species (Figs. 6-44) was compared with the geographic patterns of four environmental factors, the midwinter minimum temperature, the mean annual rainfall, elevation and vegetational zonation and the results were collected in Table 1 which shows this analysis in relation to the seven patterns of anuran distribution ascertained for the New England area (see below). It should be pointed out that in New England the environmental factors employed follow approximately the east-west topographical gradient which generally is highest in the east and lowest in the west. Figs 2-5 show that in general the lower range of these environmental values occurs in the western parts of New England and

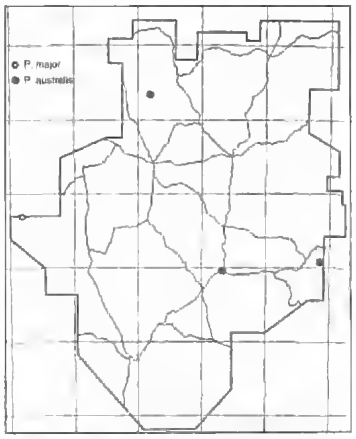

FIG. 42. *Pseudophryne spp.*

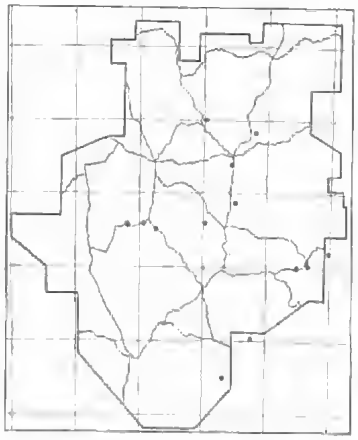

FIG. 43. *Ranidella parinsignifera*

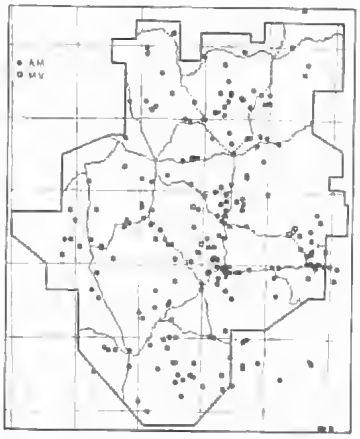

FIG. 44. *R. signifera*

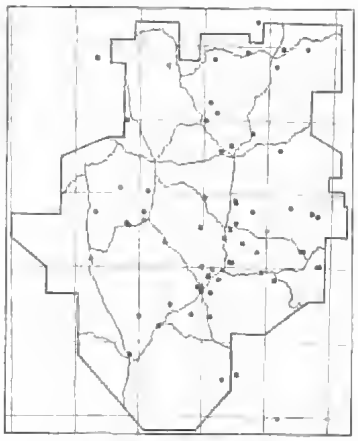

FIG. 45. *Uperoleia laevigata*

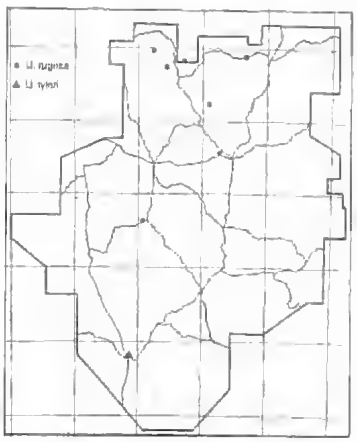

FIG. 46. *Uperoleia spp.*

the higher ones in the east along and eastward from the Great Dividing Range. It is evident that many species have wide ranges across one or more environmental parameters. Within this wider range 30% or more of site records for each species occur across narrower ranges of environmental values.

Table 2 shows the vegetational context of frog distribution in the New England region.

Table 1 shows that with the exception of the eastern group, 30% of all site records occupy the lower half of the scale in relation to winter minimum temperature, mean annual rainfall, and vegetational zonation. In the eastern species there is a marked tendency to the upper half of the scale in respect of rainfall and vegetation. The single central species *Litoria castanea* is, however, mid-range for altitude and rainfall.

The middle ranges of elevation are occupied by 27/46 (59%) of species with the exception of northern and western species which despite some variability do tend to lower altitudes.

Very striking is the distribution of New England frogs in relation to vegetational zonation in that more than 30% of site records for each of 35/46 (80%) of species are found in the DR+CL zone (Table 1).

Concentration of site records in this zone is actually much greater than is suggested by these numbers. A high mean of 78.75 (61-88)% of total site records for these 35 species falls in this particular vegetational zone (Table 2). Perhaps this should not be surprising since Table 2 shows this zone to comprise 70% of New England. This zonal concentration implies considerable collecting bias, most of the main road system being located in this zone. Despite this the authors

believe the records provide a good indication of the environmental distribution for species with a high number of site records. Some doubt must be expressed in relation to the many species for which site records are few but even these tend to fall into eastern or western profiles.

The distributional patterns of the New England frogs fall into seven groups:

Eurytopic species (Table 1; U). These are widely distributed in the area, being represented at sites scattered throughout the entire region. The species in this category are *Limnodynastes dumerilii, L. ornatus, L. tasmaniensis, Pseudophryne bibronii, Ranidella signifera, Uperoleia laevigata, Litoria booroolongensis, L. caerulea, L. fallax, L. latopalmata, L. lesueuri* and *L. peronii*. Of these, only *L. booroolongensis* has a restricted distribution outside the area. It occurs only in east central New South Wales, but the borders of its range extend well beyond the limits of the New England area. *L. caerulea* is widely distributed from arid east-central Australia to the coast and throughout the tropical north; its range extends well beyond the boundaries of New England in all directions. It is recorded from nearly all parts of New England, but sparsely. *L. fallax* and *L. lesueurii* occupy a narrow strip along most of the eastern Australian coast. Their ranges do not extend very far westward of the New England boundaries and it may be significant that the former was seldom collected in the southwestern part of the area. *L. latopalmata* occupies a large, roughly triangular distribution, the base extending along the coast from northeastern Queensland to southeastern New South Wales and the apex reaching the junction of the New South Wales and South Australian borders. *U. laevigata* is found throughout coastal eastern New South Wales and Victoria. *R. signifera, L. dumerilii,* and *P. bibronii* are widely distributed in southeastern Australia. *L. tasmaniensis* covers nearly the eastern third of the continent and *L. peronii* has a southeastern range not much smaller. *L. ornatus* extends from just south of New England northward and across the top of Australia. Cogger (1992) reported almost all of these species as being found in a variety of habitats or in places away from water. The exceptions were *L. dumerilii* which occupies permanent water of various sorts and *L. booroolongensis* which is mainly found in mountain streams. Thus, with the exception of L. *booroolongensis,* these are widely distributed species with wide ecological amplitude and/or terrestrial tendencies. These 12 species make up 26% of the frog species of the New England region.

The wide range of environmental zones shown by the 12 nearly ubiquitous species reflects their wide distribution. Although this group is adapted to a wide range of conditions there is at the 30% site record level a marked tendency towards the lower end of the respective environmental ranges.

Eastern species (Table 1, E, E+, E++). These are found only in the eastern part of the New England region. They constitute the second largest group in the area (14 species; 30%). Ten of them (E) are restricted to the extreme edge of the region and scarcely get inside the New England borders. These are *Assa darlingtoni, Kyarranus loveridgei, K. sphagnicolus, Lechriodus fletcheri, Mixophyes balbus, M. fasciolatus, M. iteratus, Litoria chloris, L. barringtonensis* and *L. subglandulosa.* They have narrow, strip-like eastern distributions in eastern Australia and their marginal entry into the New England region represents the western edges of their ranges. All are inhabitants of wet forests, *(L. chloris* is largely arboreal, the others terrestrial), such as Antarctic beech forest, rainforest and wet sclerophyll forest and their range in New England reflects the limited amount of such habitat in the region.

Except for vegetational cover, the purely eastern species have a much narrower range for all environmental parameters than do the eurytopic species. This is true even of species with more than just a few site records. Temperature and elevational ranges are narrow, predominantly middle range, while the quite narrow, rainfall ranges are to the high side of the scale, corresponding to the higher elevations of the wet forests occupied by these species. It is interesting that even at the 20% level of site records, eastern species occupy a greater variety of vegetational types compared with eurytopic species (Table 1). Indeed, two eastern species *L. barringtonensis* and *L. subglandulosa,* are found even in the DR + CL zone which for these species lies mainly in the high rainfall areas. Three eastern species have a wider range of elevation and rainfall than do other members of this group.

K. sphagnicolus, inside the boundaries of New England, is distributed along the Great Dividing Range at elevation between 800m and > 1400m but 88% of site records lie more narrowly between 800 and 1200m. It is worth noting that this species also occupies the adjoining wet forests of the steep coastal slopes of the escarpment down to altitudes of 106m (Brinerville; H.Cogger, pers. comm.), 300m (Beechwood; AMR118198-207),

327m (Forbes River, Cowarral; AMR104114), 370m and 620m (Mistake State Forest near Bowraville; (J. Monro, pers. comm.).

M. balbus ranges from 0 to >1400m but like others of its group, 30% of its site records lie more narrowly in rainfall zone 3. Some 77% of its site records fall between 800 and 1300m. A further 6 % are found at >1400m. The 18% of elevation records below 799m represent high rainfall coastal sites penetrating the Tableland via the gorges.

The geographical range of *M. fasciolatus* is greater than those of other eastern species (Figs 36, 37), extending as it does to the vicinity of Red Range near Glen Innes. Even so, this most westerly record still lies east of the Great Dividing Range (Figs 1, 37).

The small number of site records for each species of *Mixophyes* imposes caution but there is some indication that *M. fasciolatus* (58% of records) occurs at lower altitudes that does *M. balbus* (18%). More than half of the few records of *M. fasciolatus* are situated in lower coastal altitudes whereas more than half the records of *M. balbus* lie in the higher altitude zones. These two species, with *L. subglandulosa*, occur over a wider range of elevation, rainfall and vegetational types than do other eastern species (Table 1).

Four species (Table 1; E++), *Adelotus brevis, Limnodynastes peronii, Litoria dentata* and *L. verreauxii*, have wider distributions that encompass approximately the eastern half of the New England area. All occupy relatively wet habitats and all have extensive geographic ranges that include the eastern coast and the Great Dividing Range, the western limits lying within New England. The environmental correlations of these four species are very similar to that of the eurytopic species corresponding to the extensive distributional overlap of the two categories.

Pseudophryne coriacea (Table 1, E+) is intermediate between the other two eastern groups. It occupies a strip along the eastern edge of New England but is not so restricted as the first-mentioned group. Whereas west of the Great Dividing Range there are no E records and at least one third of E++ records only 2/27 of *P. coriacea* records occur here. This slightly more extensive geographic range coincides with a slightly wider temperature range of July minimum temperature and generally with a cooler, drier environment than is true for purely eastern species.

P. coriacea shares with the aforementioned species of *Mixophyes* a similar range of elevation and rainfall but in respect to vegetation all site records of this species are from DR + CL and DF + WDL zones. (Table 1,2).

Western species (Table 1; W). Three species have distributions opposite to those of the above group, occupying predominantly the western part of New England. They are *Limnodynastes fletcheri, L. salmini* and *Litoria rubella*. Of these the first two have extensive distributions in the drier western plains of New South Wales and adjacent areas extending northward into Queensland to or near the coast. *L. salmini* is cryptic or burrowing and found only after rains. *L. fletcheri*, is not so arid-adapted but is secretive except after rains. Occupying about the western two thirds of the region, it has a broader distribution in New England than do the other two. *L. rubella*, appropriately called the Desert Tree Frog, occurs throughout the central deserts of Australia and the entire tropical north. It covers over two thirds of Australia, yet its southeastern boundary runs through New England where it is found only in the north and southwest. A fourth species, *Ranidella parinsignifera*, is also a burrowing, cryptic species with an extensive distribution in the drier areas of western New South Wales. Contrary to expectations, in New England it has a central to eastern distribution being virtually unrepresented in western New England. It is included here on the basis of its general distribution. Another burrowing species, *Cyclorana platycephala*, occurs just outside the study area.

Excluding *C. platycephala*, all western species have a wide elevational range and their distributions tend towards the lower end of the minimum temperature and rainfall scales. *R. parinsignifera*, however, is unique among all groups of species in extending over four zones of rainfall at the 20% of site records level. With the eastern group it is remarkable, too, for the concentration of 30% of its site records at higher elevations (85%), an aspect shared with *P. bibroni* (85%), *L. subglandulosa* (82%) and *L. castanea* (77%).

Northern Species (Table 1; N). Two species are found only in the northern part of New England. They are *Cyclorana brevipes* and *Uperoleia rugosa*. *U. rugosa* is a species from a wide variety of habitats and an overall distribution from southern Queensland south in a wide band to Victoria. In New South Wales its distribution is mainly west of the New England region despite it being coastal in northern New South Wales and Queensland. Although it extends south of New England, it does so farther inland, just catching the northwestern tip of the region in its range. The

TABLE 1. Environmental profiles of the New England frogs (% site records - all values rounded off). See Appendix for environmental codes.

Gp.	Species		July Min. C				Elevation (m)					Rainfall (mm)							Vegetation				
		N	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	1	2	3	4	5
U	*Lit. booroolongensis*	123	33	29	37		2	33	44	21		8	36	23	15	12	7		77	2	17	1	2
U	*Lit. caerulea*	28	29	43	25		11	54	36			21	46	21	11				86	4	11		
U	*Lit. fallax*	58	52	41	7		2	16	66	16		9	41	29	19	2			79	2	17	2	
U	*Lit. latopalmata*	95	38	35	26		17	51	32	1		36	40	16	7	1			81	5	12	2	
U	*Lit. lesueuri*	76	37	37	26		15	46	40			24	42	12	9	8	5		61	1	13	1	
U	*Lit. peronii*	48	41	47	10	2	8	31	56	4		19	48	27	6				88	2	8	2	
U	*Lim. dumerilii*	60	25	48	27		5	25	52	18		8	43	32	12	2	3		75	5	10	8	2
U	*Lim. ornatus*	50	25	56	18		16	44	38	2		28	42	22	6		2		82	2	16		
U	*Lim. tasmaniensis*	259	39	37	23	2	5	17	58	20		9	34	33	20	4	1		88	2	8		1
U	*P. bibronii*	94	36	31	27	6	1	14	53	32		4	16	36	33	5	5		70	5	15	3	2
U	*R. signifera*	208	35	34	29	3	3	31	47	18	2	11	41	18	21	5	4	1	82	2	11	2	2
U	*U. laevigata*	63	32	51	16	2	2	20	64	14		5	49	18	21	5	3		76	6	14		3
E	*Lit. chlaris*	2			100			50	50						50	50					50		50
E	*Lit. barringtonensis*	4			100			50	50						75	25			50			25	25
E	*Lit. subglandulosa*	17			100				18	82			6		6	53	41		35	24	6	18	18
E	*Assa darlingtoni*	2			100			50	50							100							100
E	*K. loveridgei*	2			100			50	5	0						100							100
E	*K. sphagnicolus*	8		13	88			25	63		12				13	38	38	13	25			25	50
E	*Lech. fletcheri*	8			100		12	38	50						13	50	38				37	13	50
E	*M. balbus*	17			100		6	12	53	24	6				29	41	29		7	13	33	33	13
E	*M. fasciolatus*	7		14	86		29	29	29	29				14	43	29	14		29		43	29	
E	*M. iteratus*	2			100				100							100						50	50
E+	*P. coriacea*	27	7	61	32		4	15	67	15			4	7	59	19	11		44	7	33	11	4
E++	*Lit. dentata*	11	36	46	18		9	9	73	9			27	27	36	7			82		18		
E++	*Lit. verreauxii*	100	39	28	29	4		8	63	29		3	32	29	22	8	6		82	1	13	1	3
E++	*Adel. brevis*	89	33	45	20	1	5	15	65	16		3	28	19	34	11	5		72	1	25	1	1
E++	*Lim. peranii*	37	22	24	46		3	11	49	27	11	3	19	22	30	19	8		65	5	22	3	5
N	*C. brevipes*	2		50	50		50	50				100							100				
N	*U. rugosa*	7	43	57			29	57	14			43	43	14					86		14		
W	*C. platycephala*	1			100		100					100							100				
W	*Lit. rubella*	15	13	53	33		40	40	20			60	27	7	6				93	7			
W	*Lim. fletcheri*	71	31	38	17	14	16	52	30	3		32	48	14	4	1			89	3	9		
W	*Lim. salmini*	8		63	38		38	38	25			75	25						100				
W	*R. parinsignifera*	13	46	23	23	8		15	54	31			23	31	23	23			62	23	15		
C (end.)	*Lit. castanea*	9	78	22				11	33	44	11		22	44	33				78		22		
R	*Lit. aurea*	3		67	33				67	33			66			33			100				
R	*Lit. gracilenta*	1	100						100				100						100				
R	*Lit. nasuta*	1	100						100					100					100				
R (end.)	*Lit. piperata*	5		40	60		20	40	40					80	20				20		80		
R	*Lit. tyleri*	1			100				100							100					100		

TABLE 1 cont...

Gp.	Species		July Min. C				Elevation (m)					Rainfall (mm)							Vegetation				
		N	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	1	2	3	4	5
R	*Lim. lerraereginae*	4	25	50	25			50	50			25	50			25			75				25
R	*Neo. sudelli*	9	33	56	11		11	11	78				56	22	11		11		63	13	12	12	
R	*Noto. bennettii*	2	50	50				50	50				50	50					100				
R	*P. australis*	1	33	34	33			33	34	33		33	34				33		67				33
R	*P. major*	1			100				100					100							100		
R	*U. tyleri*	1			100			100				100							100				

few records for this group lie in the lower environmental ranges.

Central species (Table 1, C) There is only one species in this category. *Litoria castanea*, which occupies a very limited area in the Guyra district. There is a 1958 record from near Armidale but there has been only one unsubstantiated record (1991) from Armidale since then. The few records of this species are concentrated at the low end of the temperature scale., the high end of the elevational scale and the middle range for rainfall. Its habitat lies in the predominantly DR + CL zone of a long established pastoral region. The closely related and more easterly *L. aurea* has a similar environmental profile except for higher midwinter minimal temperatures and a somewhat wider range of rainfall. *Litoria castanea* is also rare, endemic and perhaps extinct.

Endemic species (Table 1, end). Two species are endemic to New England, *L. castanea* (see above) and *L. piperata*. The latter species occupies wet forests in the higher rainfall zones at higher elevations along the eastern boundary of New England and may be considered a relictual species. It is greatly to be regretted that the survival of these two species is in serious doubt.

Rare Species (Table 1,R). These are species that were found too infrequently in the New England region to produce a meaningful distribution map. They may have restricted local distributions or it may be that they are more widely distributed but seldom found by collectors because they have secretive habits or for other reasons. They are *Litoria aurea, L. gracilenta, L. nasuta, L. tyleri, Limnodynastes terraereginae, Neobatrachus sudelli, Notaden bennetii, Pseudophryne australis, P. major* and *Uperoleia tyleri*.

Pseudophryne australis was reported by Cogger (1992) to occupy an area of only about 160km radius from Sydney and restricted to the Hawkesbury Sandstone formation. The New England records represent a considerable range extension; perhaps the species is more widespread than previously thought but rare in areas peripheral to the Sydney region. *Pseudophryne major* represents a small population restricted to Mt Kaputar in the extreme northwest of New England and well separated from the coastal population in Queensland. *Litoria aurea* is a widely distributed species. No explanation can be offered as to why it should be so restricted regionally. The record of *Litoria tyleri* presumably marks the western limit of this coastal species of northern New South Wales and southern Queensland. *Uperoleia tyleri* unexpectedly provides an inland record near Tamworth, well separated from the coastal population of southeastern New South Wales and Victoria.

This is a somewhat arbitrary grouping that shows as much or as little variation across environmental parameters as other groups. Despite small numbers of records the members of this group divide into those that are essentially eastern and those that are western.

CONCLUDING REMARKS

In summary, there is a number of species that meet their distributional limits within the New England area. Two of these are endemic to New England. Most are frogs either from moist habitats and which have distributions along the eastern coast and into the Great Dividing Range, and occur only in the eastern part of New England, or those adapted to the western arid plains and occurring only in the western part of the New England region. These two groups could almost be divided by a line running north and south through the region. There are a few species with generally northern or western distributions that just get into the northern edge of the study area. Superimposed on these is a large number of eurytopic, species that occur over wide areas of Australia and are found throughout New En-

TABLE 2. Systems of vegetation in New England. Data by courtesy of H. Hines, Armidale Branch National Parks & WildlifeServices, N.S.W.

TYPE	AREA(ha)	%
Disturbed remnant (DR)	771,990	14.8
Cleared (CL)	2,600,384	53.3
Rocky complex (RC)	11,169	0. 2
Dry open forest (DF)	1,105,702	22.7
Woodland (WDL)	45,295	0.9
Moist open forest (MOF)	153,294	3 .1
Rainforest (RF)	29,762	0.6
Unmapped	40,469	0.8
	4,879,915	100.00

gland. A few species have range boundaries extending in all directions beyond those of New England but which have restricted distributions within the region. Finally, there is a group of species only recorded from a few, sometimes scattered, localities whose local distributions are hard to interpret; they may be rare or restricted to specialized local conditions or their apparent scarcity may be an artefact of collecting techniques. Ford & Macfarland (1991) recognised fifteen loose geographical categories for the birds of the New England region. It is interesting that these include the seven categories ascertained for the frogs.

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APPENDIX

TABLE 1 Environmental Codes

Code	July min. temp. (°C)	Code	Elevation (m)	Code	Rain (mm)	Code	Vegetational System
1	<0	1	0-399	1	<700	1	Disturbed remnant + cleared
2	0-2	2	400-799	2	700-799	2	Rocky complex
3	2-4	3	800-1199	3	800-899	3	Dry forest and woodland
4	4-6	4	1200-1399	4	900-1099	4	Moist open forest
		5	>1400	5	1100-1299	5	Rainforest
				6	1300-1499		
				7	1500-1699		